

PATENT

Atty. Dkt. No. APPW007729/TCQ/EPV/AG

REMARKS

This is intended as a full and complete response to the Notice of Non-Compliant Amendment dated March 9, 2006, and the Office Action dated December 2, 2005, having a shortened statutory period for response set to expire on April 9, 2006. Please reconsider the claims pending in the application for reasons discussed below.

Claims 67-139 remain pending in the application upon entry of this response. Claims 67-139 stand rejected by the Examiner. Claim numeral 130 was previously omitted in the Preliminary Amendment mailed July 18, 2005. Therefore, previously submitted claims 131-140 have been renumbered and amended as claims 130-139. Reconsideration of the rejected claims is requested for reasons presented below.

Claims 67-68, 70-76, 80-90, 94-98, 100-110, 112-116, 118-124, 126-128, 130-136, and 138-139 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Mizushima et al.*, U.S. Pat. No. 6,794,713, (herein "*Mizushima*") in view of *Cho et al.*, U.S. Pat. No. 6,926,926, (herein "*Cho*"). The Examiner asserts that *Mizushima* discloses all but one element of the currently pending claims and *Cho* discloses that element. The Examiner states that "[t]he sole difference between the instant claims and the prior art [*Mizushima*] is the starting silicon gas." (Current Office Action, p. 3). The Examiner further asserts that it would have been obvious to one of ordinary skill in the art to modify the process of *Mizushima* by the teachings to use pentasilanes by *Cho* in order to lower the impurities and temperatures and increase the quality of the deposition. The Applicant respectfully traverses the rejection.

Claims 69, 77-79, 111, 117, 125, and 129 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Mizushima* in view of *Cho*. The Examiner states that *Mizushima* and *Cho* "differ from the instant claims in the temperature and carbon source." However, the Examiner asserts that it would have been obvious to determine through routine experimentation the optimum, operable deposition temperatures and carbon source in *Mizushima* in order to increase deposition rates. The Applicant respectfully traverses the rejection.

Claims 91-93 and 137 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Mizushima* in view of *Cho*. The Examiner asserts that it would have

PATENT

Atty. Dkt. No. APPM007729/TCG/EPVAG

been obvious to determine through routine experimentation the optimum, operable cleaning of the substrate prior to deposition by etching in *Mizushima* in order to increase the quality of the layers. The Applicant respectfully traverses the rejection.

Mizushima discloses a process for selectively growing silicon-germanium films and silicon carbide films on source/drain regions of a substrate, and subsequently, selectively growing a silicon film on the silicon-germanium film or silicon carbide film. *Mizushima* describes forming the silicon film as a polycrystalline film by controlling the germanium or carbon concentration of the underlayer. *Mizushima* remains completely silent to a process for forming an epitaxial film of silicon-germanium, silicon carbide, or silicon, as claimed in the present invention. In fact, *Mizushima* teaches away from forming an epitaxial film or layer, as recited in the present claims. *Mizushima* states "[i]t was observed that the silicon carbide film 28 was **polycrystalline** and **amorphous** on the extension region" and the "crystallinity of the undoped silicon film was **polycrystalline, which is due to the fact that the silicon film cannot epitaxially grow on the undoped silicon carbide film 28** underlying the silicon film." (column 9, lines 50-58).

The Examiner states that the "chamber is heated to deposition temperatures, which can be less than 900 °C" as taught by *Mizushima*. (Current Office Action, p. 2). The only disclosure of 900°C within *Mizushima* is related to a hydrogen reduction process to remove a native oxide film. (column 11, lines 6-11). *Mizushima* describes depositing a silicon-germanium film at a temperature of 750°C (column 6, lines 24-30), depositing an undoped silicon film on the silicon-germanium film at a temperature of 850°C (column 6, lines 47-56), carbonizing the source/drain regions to form a silicon carbide film at a temperature of 880°C (column 10, line 64 to column 11, line 2), and depositing an undoped silicon film on the silicon carbide film at a temperature of 850°C (column 9, lines 53-67 and column 11, lines 34-39). The present claims recite a process that includes heating the substrate to a predetermined temperature of about 700°C or less.

Cho discloses a process for depositing silicon carbide films by a high density plasma chemical vapor deposition (HDP-CVD) process. Since the process of *Cho* uses plasma, the chamber temperature is maintained at low temperatures, such as between

PATENT

Any. Dkt. No. APPM/007729/TCG/EPVAG

120°C and 160°C. (column 13, line 45). *Cho* notes that “[a]n unusual discovery of the inventors regarding the deposition of SiC-based layers with hydrocarbon- and silicon-containing gas flows is the need for careful temperature control of the substrate.” (column 4, lines 31-34). *Cho* is completely silent to selectively depositing films, forming epitaxial films, using thermal processes, forming silicon films, forming silicon germanium films, as well as using neopentasilane as a silicon precursor, as recited by the present claims.

The Examiner states that *Cho* “teaches that pentasilanes and derivatives can be used as source gases for silicon in vapor deposition processes.” (Current Office Action, p. 3). *Cho* does disclose that a silicon-containing gas having pentasilane may be used during the plasma process to deposit silicon carbide films. However, *Cho* does not disclose using derivatives of pentasilane, as suggested by the Examiner. Also, *Cho* does not disclose neopentasilane, lacks teachings that would have motivated the selection of neopentasilane, and lacks teachings that there is a structural similarity between pentasilane and neopentasilane. “The fact that a claimed species or subgenus is encompassed by a prior art genus is not sufficient by itself to establish a *prima facie* case of obviousness.” (MPEP 2144.08, citing *In re Baird*, 16 F.3d 380, 382, 29 USPQ2d 1550, 1552 (Fed. Cir. 1994) (“The fact that a claimed compound may be encompassed by a disclosed generic formula does not by itself render that compound obvious.”); *In re Jones*, 958 F.2d 347, 350, 21 USPQ2d 1941, 1943).

Neopentasilane ((SiH₃)₄Si) is a tertiary silane containing four silyl (-SiH₃) groups bonded to a silicon atom. Pentasilane (SiH₃(SiH₂)₃SiH₃) has dissimilar physical, chemical, and structure characteristics than neopentasilane. The disclosure of such dissimilar species provides a teaching away by *Cho*. (See, e.g., *Dillon*, 919 F.2d at 696, 16 USPQ2d at 1904 (and cases cited therein). *Cf. Baird*, 16 F.3d at 382-83, 29 USPQ2d at 1552). Since *Cho* lacks disclosure to motivate the selection of neopentasilane and lacks teachings that there is a structural similarity between pentasilane and neopentasilane, the Examiner has not established a *prima facie* case of obviousness.

Mizushima further discloses forming the “silicon carbide film 28 deposited in this step consists of 50 atomic % of silicon and 50 atomic % of carbon.” (column 9, lines 49-50). *Mizushima* remains completely silent to a carbon concentration of about 5 at% or

PATENT

Atty. Dkt. No. APPM007729/TCG/EPVAG

less, such as cited by claims 81, 96, and 114. Also, *Mizushima* remains completely silent to a carbon concentration within a range from about 200 ppm to about 2 at%, such as cited by claims 82, 97, 107, 115, 127, 134, and 137-138.

Mizushima and *Cho* do not disclose neopentasilane, methylsilane, epitaxial deposition processes, a substrate temperature of 600°C, among many other claimed elements.

Therefore, *Mizushima* and *Cho*, alone or in combination, do not teach, show, or suggest a method for selectively and epitaxially depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and a non-crystalline surface within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, exposing the substrate to a process gas containing neopentasilane, and depositing an epitaxial layer on the crystalline surface to a predetermined thickness, as recited by claim 67, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and at least one feature surface within a process chamber, wherein the at least one feature surface comprises a material selected from the group consisting of an oxide material, a nitride material or combinations thereof, heating the substrate to a predetermined temperature of about 700°C or less, and exposing the substrate to a process gas containing neopentasilane to deposit a silicon-containing blanket layer across the crystalline surface and the feature surfaces, wherein the silicon-containing blanket layer contains a silicon-containing epitaxial layer selectively deposited on the crystalline surface, as recited by claim 94.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, and exposing the substrate to a process gas containing neopentasilane and a carbon source to deposit a silicon carbide blanket layer across the crystalline surface

PATENT

Atty. Dkt. No. APPW007729/TCG/EPVAG

and the feature surfaces, wherein the silicon carbide blanket layer contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface, as recited by claim 95, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature, and exposing the substrate to a process gas containing neopentasilane and a carbon to deposit a silicon carbide blanket layer across the crystalline surface and the feature surfaces, wherein the silicon carbide blanket layer contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface and a carbon concentration within a range from about 200 ppm to about 2 at%, as recited by claim 107, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a doped silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature, and exposing the substrate to a process gas containing neopentasilane and a dopant source to deposit a silicon-containing blanket layer across the crystalline surface and the feature surfaces, wherein the silicon-containing blanket layer contains a silicon-containing epitaxial layer selectively deposited on the crystalline surface and a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 112.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing silicon-containing a material on a substrate, comprising positioning a substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature, and exposing the substrate to a process gas containing neopentasilane, a carbon source and a dopant source to deposit a doped silicon carbide blanket layer across the crystalline surface and the feature surfaces, wherein the doped silicon carbide blanket layer

PATENT

Atty. Dkt. No. APPM007729/TCG/EPI/AG

contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface, as recited by claim 113, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a doped silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature, and exposing the substrate to a process gas containing neopentasilane, a carbon source and a dopant to deposit a silicon carbide blanket layer across the crystalline surface and the feature surfaces, wherein the silicon carbide blanket layer contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface and a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 121, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for selectively and epitaxially depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and a non-crystalline surface within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, exposing the substrate to a process gas containing neopentasilane and a carbon source, and depositing a silicon carbide epitaxial layer on the crystalline surface to a predetermined thickness, as recited by claim 126, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for selectively and epitaxially depositing a silicon-containing material on a substrate, comprising positioning a substrate containing a crystalline surface and a non-crystalline surface within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, exposing the substrate to a process gas containing neopentasilane, a carbon source and a dopant source, and depositing a silicon carbide epitaxial layer on the crystalline surface, wherein the silicon carbide epitaxial layer has a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 133.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for selectively and epitaxially depositing a silicon-containing material on a

PATENT

Atty. Dkt. No. APPW007729/TCG/EPVAG

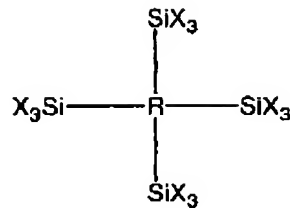
substrate, comprising positioning a substrate containing a crystalline surface and a non-crystalline surface within a process chamber, heating the substrate to a predetermined temperature, exposing the substrate to a process gas containing neopentasilane, a carbon source and a dopant source, and depositing a silicon carbide epitaxial layer selectively on the crystalline surface, wherein the silicon carbide epitaxial layer has a carbon concentration within a range from about 200 ppm to about 2 at% and a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 134, and claims dependant thereon.

Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for blanket depositing a doped silicon-containing material on a substrate, comprising exposing a substrate to pretreatment process containing a HF solution positioning the substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, and exposing the substrate to a process gas containing neopentasilane and a carbon source to deposit a silicon carbide blanket layer across the crystalline surface and the feature surfaces, wherein the silicon carbide blanket layer contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface, a carbon concentration within a range from about 200 ppm to about 2 at%, and a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 137.

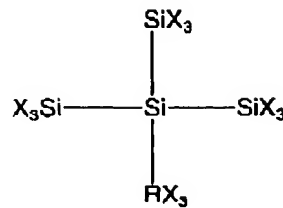
Mizushima and *Cho*, alone or in combination, do not teach, show, or suggest a method for selectively and epitaxially depositing a silicon-containing material on a substrate, comprising positioning the substrate containing a crystalline surface and feature surfaces within a process chamber, heating the substrate to a predetermined temperature of about 700°C or less, exposing the substrate to a process gas containing a carbon source and a silicon precursor comprising a chemical structure:

PATENT

Atty. Dkt. No. APPM007729/TCG/EP/AG



or



, wherein each X is

independently hydrogen or halogen and R is carbon, silicon or germanium, and depositing a silicon carbide blanket layer across the crystalline surface and the feature surfaces, wherein the silicon carbide blanket layer contains a silicon carbide epitaxial layer selectively deposited on the crystalline surface, a carbon concentration within a range from about 200 ppm to about 2 at%, and a phosphorus concentration within a range from about 10^{19} atoms/cm³ to about 10^{21} atoms/cm³, as recited by claim 138, and claim 139 dependant thereon.

Withdrawal of the rejections is respectfully requested.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the claimed invention.

Having addressed all issues set out in the Office Action, the Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,



John-Paul F. Cherry
Registration No. 57,323
PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd. Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Agent for the Applicant

446752_1